Feb. 15, 1927. 1,617,659

E. WHINNEN

HYDRAULIC CORE DRILL

Filed Jan. 5, 1925

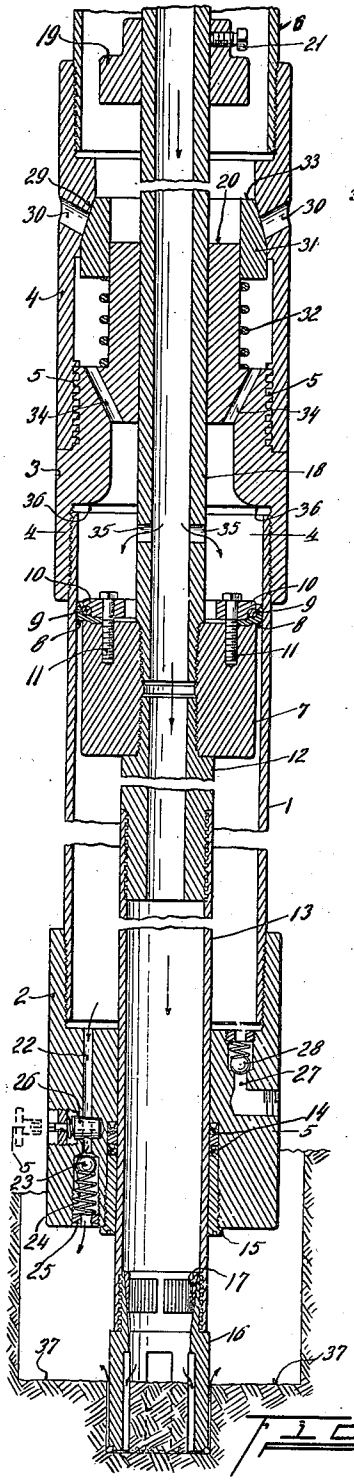


Fig. 1.

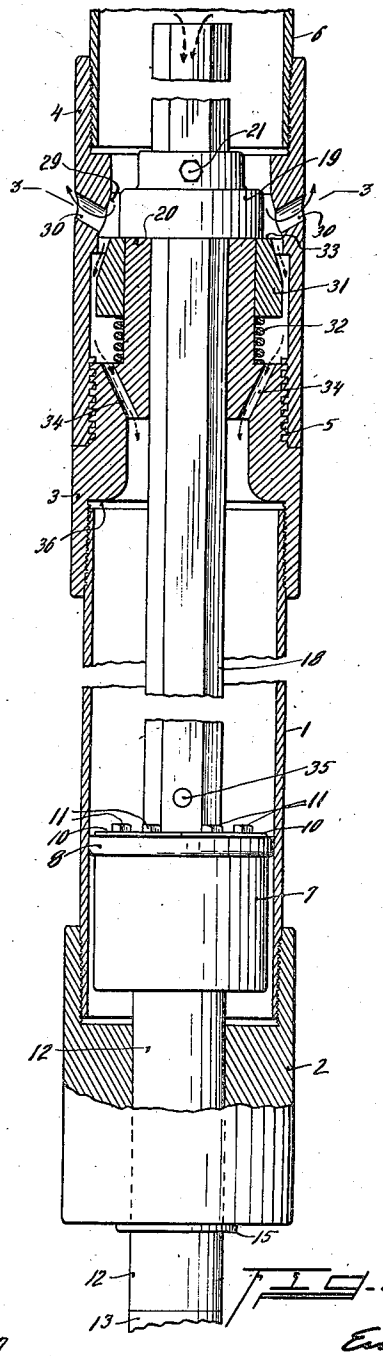


Fig. 2.

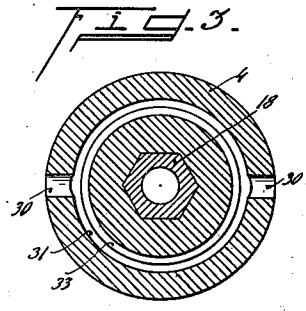


Fig. 3.

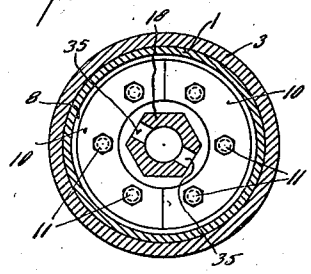


Fig. 4.

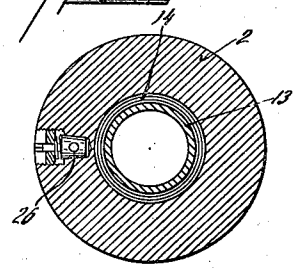


Fig. 5.

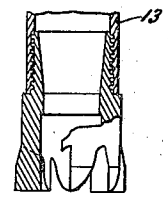


Fig. 6.

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UNITED STATES PATENT OFFICE.

EUGENE WHINNEN, OF REPUBLIC, MICHIGAN.

HYDRAULIC-CORE DRILL.

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This invention relates to an improved type of hydraulic core drill, adapted for use in connection with the ordinary rotary well drilling equipment and has for an object to provide a core drill adapted to be connected to the lower end of a string of drill pipe and to be lowered into a well bore and rotated by the drill pipe, the drill pipe being operated by the usual rotary surface equipment and maintained at a given elevation during a core drilling operation, and the core drill being of an axially expansible character whereby the core cutter is fed downwardly relative to the drill body and drill pipe, by the pressure of the circulating fluid which is forced down the drill-pipe by the usual mud-water circulation equipment at the surface of the well.

Another object is to eliminate the necessity of any special surface equipment and to utilize the standard rotary drill table for rotating the drill pipe and drill, and the standard mud-water circulation system for causing an axial feed of the drill into the formation in a core drilling operation.

Another object is to provide a core drill of an axially expansible character in which the feeding stroke of the core cutting means is limited to a predetermined length and is effected by the pressure of the circulating fluid, and to make provisions whereby when the core cutting reaches the limit of its stroke, a change in the flow of the circulating fluid is effected to give a visual indication at the well surface.

A further object is to provide means for regulating the rate of axial feed of the core cutting means.

Another object is to provide means for varying the length of the feeding stroke of the core cutting means.

Another object is to provide a core drill of the cylinder and piston type in which the cylinder is attached to the lower end of a drill pipe and is rotated thereby at a given elevation above the bottom of the well bore, and in which the core barrel is attached to the piston and extends downwardly through and beyond the cylinder head and has a core cutter at its lower end, the piston being driven downwardly by the circulating fluid to feed the cutter into the formation during rotation of the drill.

Various other objects and advantages will be more fully apparent from the following description of the accompanying drawings which form a part of this disclosure, and which illustrate a preferred form of embodiment of the invention.

Of the drawings:

Fig. 1 is a vertical section illustrating the drill in boring position in a well bore.

Fig. 2 is a similar view, partly in elevation, showing the parts in the positions they occupy at the end of a core drilling stroke.

Fig. 3 is a section on line 3—3 of Fig. 2.

Fig. 4 is a section on line 4—4 of Fig. 1.

Fig. 5 is a section on line 5—5 of Fig. 1, and

Fig. 6 illustrates a modified form of core cutter.

Heretofore it has been the general practice in drills fed by hydraulic means, to provide a special type of drilling equipment at the well surface operated by hydraulic pressure to feed downwardly the entire drill pipe string. Such special equipment is very expensive and is generally utilized for the entire drilling of the well, it being quite impossible to utilize such equipment only for core drilling and the standard rotary table for the drilling of the well bore.

The present invention renders it possible to utilize the standard rotary table in the usual manner in forming the well bore and provides a core drill adapted for attachment to the standard string of drill-pipe and to be rotated thereby, the drill-pipe in this instance being driven by the standard rotary table as in a well boring operation. The drill-pipe string is not fed downwardly in a core drilling operation but is rotated at a given elevation such as to maintain a core-drill body at a given height above the bottom of the well bore. The core-drill is of the nature of a cylinder and piston, the cylinder being the drill body which is attached to the drill-pipe and the piston carrying the core-barrel having at its lower end a core-cutter. This provides an axially expansible drill in which the pressure of the circulation water forced down the drill-pipe serves to force the piston downwardly in the cylinder to effect a downward feed of the core-barrel and core-cutter into the formation.

In the drawings the drill body is shown

as comprising several sections screw-threaded together, 1 designating a cylinder, 2 a cylinder-head screw threaded upon the lower end thereof, and 3, 4 designating a two part coupling the lower member 3 being screw-threaded on the upper end of the cylinder 1, the members 3, 4 being screw-threaded together as at 5, and the upper member having an internal screw-thread adapting it for attachment to the lower end of a string of rotary drill-pipe 6. Adapted to reciprocate in the cylinder 1, is a piston member 7 provided at its upper end with a cupped ring packing 8, preferably of leather, which is secured in place by a split spreader ring 9 and a two part ring plate 10, said ring plate clamping the packing to the top of the piston member by means of bolts 11.

The piston member 7 has a central bore and screw-threaded into the lower end thereof is a tubular rod 12 and screw-threaded upon the lower end of said rod is a core receiving barrel 13, the rod and barrel constituting a hollow piston rod extending outwardly from the drill body through the bore in the cylinder head 2 and through suitable packing 14 and a suitable packing gland 15 functioning to maintain the packing in place.

A tubular core cutter 16 is detachably secured to the lower end of the core barrel 13, the cutter shown in Fig. 1 being the ordinary type of diamond core cutter provided with a split core-retaining ring 17, while the cutter illustrated in Fig. 6, which may if desired be substituted for that shown in Fig. 1, is of the ordinary toothed type. The diamonds or teeth in these cutters are arranged to provide such clearance around the core as to permit a circulation of the fluid around the core downwardly to the cutting edges and upwardly around the outer periphery of the cutter and core barrel, as indicated by the arrows in Fig. 1.

Screw-threaded into the upper end of the bore of the piston member 7, is a tubular drive rod 18, which extends upwardly through the central bore in the coupling member 3 and to a considerable distance upwardly into the drill-pipe 6. This drive rod 18 is slidable in relation to said coupling member 3, and in the present instance is hexagonal in cross-section as is the bore in the member 3 in which it engages, thus the drive rod is, in effect, slidably keyed in the coupling member 3 so as to be rotated therewith, while at the same time said rod is capable of being axially translated relative to said member.

An attachment or stop collar 19 is adjustably secured upon the drive rod 18 above the coupling member 3 and by engaging with the upper surface 20 of said coupling member serves to limit the downward feeding stroke of the drive-rod, the piston and the core barrel and core cutter carried thereby. It will be evident that the length of such feeding stroke may be varied by loosening the set-screw 21 and readjusting the collar 19 to a different location upon the drive rod 18.

In the cylinder head 2 there is provided an exhaust passage 22 normally closed by a ball valve 23 which is yieldingly held closed by a spring 24 retained within the enlarged lower end of said passage by a hollow plug 25 having a screw-threaded engagement therein. By adjustment of said plug the tension of the spring 24 may be varied, the function of the spring being to hold the ball valve 23 closed against the head of fluid within the cylinder while the drill is being lowered into the well bore and until the piston starts its downward travel in a core drilling operation. A governor valve 26 controls the exhaust of the fluid through the exhaust passage 22 thereby regulating the speed of axial travel of the piston and associated parts, said control valve being pre-adjusted, preferably by means of a wrench, illustrated in dotted lines in Fig. 1.

A filling passage 27 in the cylinder head 2 has a check valve 28 which prevents escape of liquid from the cylinder through said passage, the outer end of the passage 27 being provided with screw-threads for attachment thereto, prior to lowering the drill into the well bore, of a pipe or other means by which the lower portion of the cylinder may be initially filled with fluid.

The upper coupling member 4 is provided with a tapered concentric valve seat 29 and in the region of said seat said coupling member is provided with one or more ports 30. Adapted to engage said seat and normally close the said ports is a sleeve valve member 31, slidably mounted upon the upper reduced portion of the coupling member 3 and normally maintained closed by a coil spring 32, the upper surface 33 of the valve sleeve 31 being some distance above the upper surface 20 of the coupling member 3 when the valve 31 is in closed position, as shown in Fig. 1. Passages 34 are provided in the coupling member 3 to provide a flushing of mud or sand from the valve 31, as will later be explained.

Just above the piston 7 the drive rod 18 has transverse ports 35 affording communication from the bore of the drive rod to the cylinder above the piston.

Having described the different mechanical features of the drill, I will now explain its mode of operation and the functions of its several component parts.

With the complete drill assembled as shown, and the stop collar 19 preadjusted to the proper position upon the drive rod 18 to give the required length of feeding

stroke, the drill body is screwed upon the lower end of the string of drill pipe 6 preparatory to a lowering of the drill into the well bore, and a suitable pipe or other means to supply clear water under pressure, is screwed into the filling passage 27 in the cylinder head 2. Water under pressure is in this manner forced into the drill body below the piston 7 and will force the piston and associated parts upwardly until the split plate 10 abuts the stop shoulder 33 upon the coupling member 3.

The drill and drill pipe are then lowered into the well bore in the manner and with the surface equipment usually employed in rotary well drilling, until the core cutter or bit engages the bottom of the bore. The drill string is then elevated slightly so as to relieve the bit of the weight of the drill string, after which the drill stem will be properly connected with the rotary drill table at the surface, and the usual connection with the circulation pump made through the ordinary rotary swivel, as is now common practice.

This provides for the rotation of the drill at a given elevation from the bottom of the well bore and for the forcing of mud-laden fluid downwardly in the string of drill pipe in the usual manner.

The fluid being pumped down the string of drill pipe, will enter the upper end of the tubular drive rod 18, as indicated in Fig. 2, and be forced downwardly through said rod, the piston 7, the tubular rod 12 and into the core barrel 13, said fluid discharging around the periphery of the core, and then upwardly around the outer periphery of the core cutter or bit 16, as indicated by the arrows in Fig. 1. This discharge will be only of such degree as will be sufficient to keep the core washed free of any accumulation of the circulating mud in the fluid.

The circulating fluid entering the cylinder above the piston through the transverse ports 35 will exert its pressure upon the upper surface of the piston 7 and drive the piston and its associated parts downwardly so that with a rotation of the drill, the core cutter or bit 16 will exert an adequate boring pressure on the formation, and will provide a constant axial feeding of the cutter and core barrel as the core is formed.

With the axial feed of the piston 7, the clear water with which the lower portion of the cylinder is initially charged, will be exhausted through the exhaust passage 22 and past the ball valve 23, as will be permitted by the preadjustment of the control valve 26, it being understood that this valve, by reason of controlling the rate of exhaust, thereby controls or governs the relative speed of the axial feed of the piston and the core cutter and barrel.

This axial feed of the piston will continue until the abutment stop 19 upon the drive rod 18 abuts the upper surface 30 of the coupling member 3, as shown in Fig. 2, such abutment providing a definite stop to limit the stroke of the core cutter and consequently the length of the sample core to be obtained in the core cutting operation.

As the cutter approaches the end of its stroke it is desirable to indicate this at the well surface. Such indication is effected by the opening of the relief ports 30, this being effected by the engagement and translation of the valve sleeve 31 by the stop collar 19 during the final part of its downward travel, the translation of the valve sleeve effecting an uncovering of the ports 30, as shown in Fig. 2.

With the ports 30 so opened, relief is provided for the column of fluid being pumped down the drill pipe, and the effect of such relief will be immediately noticeable on the pump gauges at the well surface, and further will be indicated at the surface by the change in return flow of the mud laden fluid. When such surface indications give warning to the operating crew that the drilling feed has ceased, the operator will stop the rotary table and discontinue the circulation of the mud laden fluid, and will then draw the drill-pipe and drill, the core retainer 17 being effective to retain the core within the core barrel.

After the drill is drawn from the well the core barrel will be disconnected from the drill and the core removed therefrom. When this is to be done the lower end of the tubular rod 12 projects considerably below the cylinder head (see Fig. 2) so that a wrench or tong may be applied thereto to prevent an unscrewing of said rod from the piston while the core barrel is being unscrewed.

It will be evident that with the parts in the positions shown in Fig. 2, and with the circulation stopped the column of fluid then in the drill pipe will drain through the ports 30 as the pipe is withdrawn from the well bore, and it will also be evident that with such draining of the drill pipe, sand and mud may possibly settle around the valve sleeve 31 so as to prevent its subsequent return to normal, until washed clean, therefore, for the purpose of facilitating the washing away of such mud or sand before the drill is again used, the passages 34 are provided, so that clear water being used to flush clean the seat 29 and valve sleeve 31, will flush the accumulated mud downwardly through the passages 34 and into the cylinder, as indicated by dotted arrows in Fig. 2.

Thus I have provided a core drill adapted for rotation at a given elevation above the bottom of a well bore, and which is of an axially expansible character, with the ax-

ially movable portion thereof provided with the core cutting and retaining means and fed forwardly in a core cutting operation by the pressure of the circulating fluid. Further I provide a governor means regulating the speed of the axial feed and a preset means limiting the length of the core cutting stroke, together with means effecting an indication at the well surface when the end of such stroke is reached.

It is of advantage, especially in the use of diamond core bits, to provide a relatively small bit, as shown in Fig. 1, for instance, where a three-inch core cutter is used, such cutter is usually provided with eight diamonds, whereas if the drill were formed to include reaming cutters for boring, the entire hole at one operation with the taking of a core, it would be necessary to provide fifty-six diamonds for a seven and five-eighths bore, and this would be prohibitive from a standpoint of the cost of the diamonds.

Further by taking only a small core in a larger well bore and without continuing the boring of the well bore by side reaming cutters or other like means, there remains plenty of room at the bottom of the bore for the sidetracking of any bits of metal or hard substances which may be in the bore, and the bottom wall of the well bore provides a shelf around the core bit, as at 37, upon which such hard substances may collect so as not to cause injury to the cutter, which they would do if the cutter were required to reduce all of such hard substances to such a degree of fineness as to be carried away by the circulating fluid.

While the specific embodiment of the invention herein illustrated and described is fully capable of fulfilling all of the objects primarily stated, it is to be understood that I do not wish to limit the invention in this regard for it is susceptible of embodiment in various other forms, all coming within the scope of the claims, which follow:

I claim:

1. In a rotary boring device, the combination of: a body constituting a cylinder adapted to be attached to the lower end of a string of rotary drill-pipe conveying circulation fluid downwardly into a well bore; a piston unit axially slidable within said cylinder and having a hollow piston rod projecting below the body and a boring element attached to the lower end of said rod, said piston unit being slidably keyed to the body for unitary rotation therewith and for axial translation relative thereto with its upper surface exposed to the pressure of the circulation fluid to thereby effect a downward feeding of the boring element into the formation of the bottom of the well bore during a rotation of the device; means permitting an initial charging of the cylinder below the piston with fluid to maintain the piston unit elevated; and automatic means operable to exhaust said fluid from below said piston at a predetermined rate to control the feeding speed of the piston and associated parts.

2. In a rotary boring device, the combination of: a body constituting a cylinder adapted to be attached to the lower end of a string of rotary drill-pipe conveying circulation fluid downwardly into a well bore; a piston unit axially slidable within said cylinder and having a hollow piston rod projecting below the body and a boring element attached to the lower end of said rod, said piston unit being slidably keyed to the body for unitary rotation therewith and for axial translation relative thereto with its upper surface exposed to the pressure of the circulation fluid to thereby effect a downward feeding of the boring element into the formation of the bottom of the well bore during a rotation of the device; abutment means associated with the piston unit and adapted to engage the body to limit the feeding stroke of said piston unit, said abutment means being adjustable to vary the length of said feeding stroke.

3. In a rotary boring device, the combination of: a body constituting a cylinder and adapted to be attached to the lower end of a string of rotary drill-pipe conveying circulation fluid downwardly into a well bore; a piston unit slidable within said cylinder and having a core-barrel constituting a hollow piston rod projecting below the body, said body having relief ports above the piston; a valve normally closing said ports; a core-cutter attached to the lower end of the core-barrel, the piston unit being slidably keyed to the body for unitary rotation therewith and for axial translation relative thereto with its upper surface exposed to the pressure of the circulation fluid to thereby effect a downward feeding of the piston, core-barrel and core-cutter during rotation of the device; means for limiting the feeding stroke of the piston unit; and means for opening said valve at the end of said feeding stroke to release the fluid above the piston.

4. In a rotary boring device, the combination of: a body constituting a cylinder and adapted to be attached to the lower end of a string of rotary drill-pipe conveying circulation fluid downwardly into a well bore; a piston unit slidable within said cylinder and having a core-barrel constituting a hollow piston rod projecting below the body; means permitting an initial charging of the cylinder below the piston with fluid, the piston unit being slidably keyed to the body for unitary rotation therewith and for axial translation relative thereto with its upper surface exposed to the pressure of the circu-

lation fluid to thereby effect a downward feeding of the piston, core-barrel and core-cutter during rotation of the device, the body having an exhaust passage to exhaust the fluid from below the piston; and governor means controlling said exhaust to regulate the feeding speed of the piston and associated parts.

5. In a rotary boring device, the combination of: a body constituting a cylinder and adapted to be attached to the lower end of a string of rotary drill-pipe conveying circulation fluid downwardly into a well bore; a hollow piston within the cylinder and adapted to be driven downwardly by the pressure of the circulation fluid; a core-barrel secured to the piston and constituting a hollow piston rod projecting below the body; a core-cutter attached to the lower end of the core-barrel; a drive-rod attached to the piston and extending upwardly into the drill-pipe, said drive-rod being slidably keyed to the body for unitary rotation therewith and for axial translation relative thereto, and the drive-rod, piston and core-barrel constituting a conduit entraining fluid from the drill-pipe to the core-cutter; a stop element on the drive-rod for engaging a stop on the body to limit the boring stroke of the piston unit, said stop element being adjustable to vary said stroke; and means for governing the axial feeding speed of the piston.

6. In a rotary boring device, the combination of: a body constituting a cylinder and adapted to be attached to the lower end of a string of rotary drill-pipe conveying circulation fluid downwardly into a well bore; a hollow piston within the cylinder and adapted to be driven downwardly by the pressure of the circulation fluid; a core-barrel secured to the piston and constituting a hollow piston rod projecting below the body; a core-cutter attached to the lower end of the core-barrel; a drive-rod attached to the piston and projecting upwardly into the drill-pipe, said drive-rod being slidably keyed to the body for unitary rotation therewith and for axial translation relative thereto, and the drive-rod, piston and core-barrel constituting a conduit entraining fluid from the drill-pipe to the core-cutter; a stop element on the drive-rod for engaging a stop on the body to limit the boring stroke of the piston unit, said stop element being adjustable to vary said stroke; means for governing the axial feeding speed of the piston; and valve means operated by said stop element near the end of its downward stroke to effect a change in the flow of the circulation fluid, such change being visible at the well surface and serving as an indication of a completion of the feeding stroke of the core-cutter.

7. In a rotary boring device, the combination of: a body constituting a cylinder adapted to be attached to the lower end of a string of rotary drill-pipe conveying circulation fluid downwardly into a well bore; a piston unit axially slidable within said cylinder and having a hollow piston rod projecting below the body and a boring element attached to the lower end of the rod, said piston unit being slidably keyed to the body for unitary rotation therewith and for axial translation relative thereto with its upper surface exposed to the pressure of the circulation fluid to thereby effect a downward feeding of the boring element into the formation of the bottom of the well bore during a rotation of the device; means permitting an initial charging of the cylinder below the piston with fluid to maintain the piston unit elevated; automatic means operable to exhaust said fluid from below said piston at a predetermined rate to control the feeding speed of the piston and associated parts; and means operable by the piston unit near the end of its downward stroke to effect a change in the flow of the circulation fluid, such change being visible at the well surface and serving as an indication of a completion of the feeding stroke of the piston unit.

8. In a rotary boring device, the combination of: a cylinder forming a piston chamber and adapted to be attached to the lower end of a string of rotary drill-pipe conveying circulation fluid downwardly into a well bore; a piston axially slidable within said chamber and having a piston rod projecting below said cylinder, said piston being slidably keyed to said cylinder for unitary rotation therewith and for axial translation relative thereto with its upper surface exposed to the pressure of the circulation fluid to thereby effect a downward feeding of the piston, and said cylinder having a relief port above said piston and an exhaust passage below said piston; a boring element attached to the lower end of said piston rod; means permitting an initial charging of the piston chamber below the piston with fluid to support said piston; means yieldingly maintaining said exhaust passage closed until pressure is applied to the circulation fluid; means governing the exhaust through said exhaust passage of the fluid in said chamber below the piston, to regulate the feeding speed of the piston; a valve normally closing said relief port; and means associated with the piston and serving to effect an automatic opening of said relief valve when the piston nears the end of its feeding stroke.

9. In a rotary boring device, the combination of: a cylinder unit and a piston unit slidably keyed together for unitary rotation, one of said units being adapted to be attached to the lower end of a string of drill-pipe conveying circulation fluid downwardly into a well bore and the other of said units being provided at its lower end with a boring element and arranged to be axially trans-

lated downwardly by the pressure of said circulation fluid; means for limiting the feeding stroke of said boring element; means for governing the feeding speed of said boring element; and means for effecting a change in the flow of the circulation fluid when the boring element reaches the end of its feeding stroke, such change being visible at the well surface and serving as an indication of the completion of said feeding stroke.

Signed at Three Sands, Oklahoma, this 12th day of Nov., 1924.

EUGENE WHINNEN.